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THE DEVELOPMENT OF THE DENTAL LIQUID RATION

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13. ABSTRACT (Maximum 200 words) The Dental Liquid Ration (DLR) is designed for military personnel unable to eat solid food due to problems such as maxillofacial injuries, wired jaws, oral surgery, dental disease, or swallowing difficulties. The ration will be used by the Army, Air Force and Navy at field and fixed hospital sites, as well as Department of Veteran's Affairs (VA) hospitals. The DLR consists of dehydrated powders that, when reconstituted with water, are sippable through a straw and taste like normal components of a meal. Thirty products supporting a three-day menu cycle consist of products such as chicken barbecue, lyonnaise potatoes, buttered corn, and chocolate mocha cake. There are also six flavors of a between-meal dairyshake. The DLR comes packaged in either individual serving pouches or in a Ten-Patient Meal Module. Two producibility tests have been successfully completed, as well as focus group testing, Army Readiness Training Evaluation Program testing, small scale hospital testing, and five day user testing at tri-service and VA hospitals. A three year storage study at 80°F has also been completed. All components received acceptable ratings for sensory attributes. The DLR was transitioned to the Defense Personnel Support Center in October 1992 and will be available for procurement by the military services in the fall of 1993.				
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PREFACE

The development of the Dental Liquid Ration (DLR) was initiated by a requirement from the U.S. Army's Office of the Surgeon General (OTSG) with U.S. Air Force and U.S. Navy cosponsorship. The Department of Veteran's Affairs also plans to use the DLR. Thirty food components and six flavors of between meal dairyshakes have been developed. The DLR has a three year shelf life at 80°F and has undergone producibility testing, user testing, and consumer acceptability testing. The DLR was transferred to the Defense Personnel Support Center (DPSC) in October 1992 for procurement by the Armed Forces.

The author would like to give special thanks to Ms. Susan Erickson and Ms. Carol Shaw, Food Technology Division (FTD), Food Engineering Directorate (FED), U.S. Army Natick Research, Development and Engineering Center (Natick) for their continuous guidance and technical expertise. In addition, many thanks are given to all past and present members of the Deployable Medical Systems (DEPMEDS), Joint Working Group, Falls Church, Virginia, for their cooperation and enthusiastic support of this project. Acknowledgment is given to personnel from the Subsistence Protection Branch, FTD, FED, Natick, for their contributions in the area of packaging development and support of the DLR. The author would also like to thank Dr. Simone O. Adams and coworkers of the Soldier Science Directorate, Natick, for their outstanding efforts in field testing the DLR. As well, the author thanks the many food technologists, hospital dietitians, and patients whose technical comments have greatly helped to improve this ration.

THE DEVELOPMENT OF THE DENTAL LIQUID RATION

INTRODUCTION

Background

A requirement was submitted to the U.S. Army Natick Research, Development and Engineering Center (Natick) by the Army Office of The Surgeon General (OTSG) in FY86 to develop a ration for military personnel who are unable to eat solid food. The OTSG requirement stated, "These items must taste like components of a normal meal, be easy to prepare, be shelf stable (three years at 80°F), usable by patients in and out of hospital situations, have acceptable sensory characteristics, and fulfill the patients' nutritional requirements."

The chronology of the Dental Liquid Ration (DLR), project AAFN 88-5, is as follows:

- a. 1 October 1985 - U.S. Army (OTSG) submitted a requirement to Natick for the "Liquid Ration-Hospital", project A 88-5.
- b. 6 February 1987 - Air Force requested cosponsorship. Project became AAF 88-5.
- c. 31 July 1987 - Navy requested cosponsorship. Project became AAFN 88-5.
- d. 11 April 1988 - Liquid Ration-Hospital, project AAFN 88-5, renamed Dental Liquid Ration, project AAFN 88-5, on the recommendation of Colonel Cronin (Retired), Chief, Dietitian Section, Army Medical Specialist Corps, in order to more specifically identify the product.

Requirements

The following objectives were established in order to meet the requirements of project AAFN 88-5, as stated by the Army OTSG:

(a) The new ration will consist of a variety of menu items to support five days of meal requirements with three meals per day. Breakfast components shall at a minimum provide an entree and a cereal. Dinner and supper components shall at a minimum provide cream soup, entree, starch, vegetable and a dessert. There will be no repetition of entrees, soups or dessert items within the five day menu. A between meal milkshake type nutritional supplement will also be provided in at least 12 different flavors.

(b) The products will be dehydrated and easily reconstituted with water at a temperature appropriate to the product (i.e., beef and gravy—hot; milkshake, pudding—cold).

(c) The products will serve a dual purpose for pureed/dental soft diet requirements and dental liquid diet requirements. This will necessitate product reconstitution with different quantities of water. The maximum reconstituted portion size of individual meal components will be eight ounces (240cc).

(d) The dehydrated products will be shelf stable with a minimum shelf life of three years.

(e) The products will be packaged in individual serving packages. Individual meal components will be combined and packaged into a complete meal. Reconstitution instructions will be printed on each package.

(f) The products will be formulated to provide adequate nutrition and acceptability without solid food supplementation. Meal components shall provide on average a minimum of 2500 kilocalories (Kcals) when reconstituted with water and meet at least 80 percent of the Recommended Daily Allowance for males between the ages of 19 to 51.

(g) The new menu items, in addition to 12 flavors of nutritional supplement will include 6 entrees, 6 vegetables, 6 starches, 6 desserts and 10 cream soups. These items will supplement the four breakfast, entree, vegetable, starch and dessert items previously developed.

DEVELOPMENT

Research and Development of Components

Initial research was done to develop modified or restricted diets for the new cook-freeze system at the Walter Reed Army Medical Center. Among the special diets to be developed were the dental liquids. The dental liquid represented a totally new concept in the feeding of patients who could not swallow solid food. The meals were made with sufficient water and comminuted to make them sippable through a straw, then seasoned appropriately for the diluted state. Meals were then frozen, later to be thawed and reheated for consumption. Entree items prepared in this way initially exhibited a problem because of the gritty, grainy texture. However, utilizing freeze-dehydrated meat in place of regular meat produced a smooth liquid drink, which was also high in protein. This process was a major breakthrough in obtaining a diluted product with an acceptable mouthfeel which tasted like a normal component of a meal, and not like the watered-down version typical of most hospital diets.

Even though utilizing freeze-dehydrated meat was a big improvement over normal dental liquid diets, several deficiencies still existed. Because of the difficulty in obtaining small quantities of the freeze-dehydrated meat component, the unavailability of this product to the outpatient, the uniqueness of the cook-freeze system, and the numerous small hospitals who did not have a cook-freeze system, a new processing technology for these products had to be developed.

Natick developed a method to dehydrate an entire component of a meal. In essence, it involved preparing and comminuting the dental liquid and subsequently freeze dehydrating the entire product.

The resulting dry meal components were reconstituted by placing them in a blender, adding 1 cup of either hot or cold water, as appropriate, and blending for 30 seconds. These components offered the following advantages: they needed no refrigeration for storage, were easier to prepare, allowed increased variety, and offered a smooth consistency with no grittiness.

Even though freeze-dehydrating the entire meal component was very successful, there were some drawbacks associated with this technology. First, there was not a wide industrial base to manufacture dental liquids in this manner. Therefore, it would increase costs and would also jeopardize the need for quick response during mobilization of units. Thus, the development of the DLR, utilizing dry blend technology, was undertaken to develop a less costly, more commercially producible product. The dry blending technology used ingredients already commercially dehydrated. Therefore, the producer needs only to blend these dry ingredients together for the desired meal component.

When research first began on the dry-blending technology, a market survey of commercially available freeze-dehydrated ingredients was conducted. Because of the great number of dry-blended items such as soups and sauces on the market, there were many high quality, commercial ingredients available. Spray-dried meat powders worked very well in products. However, it was determined that freeze dried vegetable powders provided better product flavor characteristics than did the spray-dried vegetable powders.

Existing dry meal items, such as dry cereals, and dehydrated military ration items, such as Long Range Patrol entrees, that could be pulverized into powders and diluted with water were researched as potential dental liquid components with no modification to their existing formulas.

The military ration components were less promising than originally anticipated due to textural and flavor problems that occurred when these items were powdered and liquefied.

Dry cereals (e.g., Special Ktm, cornflakes) caused grittiness and separated out when ground into a powder and reconstituted. To remedy this problem, hot cereals (e.g., grits, oatmeal, farina) were cooked, freeze-dried, and ground into powders. The hot cereals were then combined with creaming agents, and/or fruit powders to produce a cereal with acceptable texture and flavor. The products can be rendered by hand into solution using specialized water-dispersible ingredients (e.g., creaming agents and starches).

Because of the difficulty in developing such a wide variety of products, as well as the amount of liquid a patient can consume at one meal, the original requirement to include cream soups in the five-day menu was eliminated.

More than 100 products for the five-day menu were developed. A technical panel comprised of food technologists trained for familiarity with dental liquids, their proposed uses, and desired characteristics (easy to pull through a straw, grittiness, and flavor attributes) evaluated the items. The 50 highest rated items were selected.

Simultaneously, 12 flavors of between meal dairyshake type nutritional supplements were developed using dry blend technology. Dairyshake acceptability scores from consumer panels ranged from 6.9 to 7.5 on a 9 point hedonic scale (1, dislike extremely; 5, neither like or dislike; 9, like extremely). At this time a decision was made by members of the Deployable Medical Systems (DEPMEDS), Joint Working Group to decrease the number of between meal milkshake type supplements from 12 flavors to 6. The following flavors were chosen based on acceptability data: chocolate, vanilla, strawberry, eggnog, orange, and banana. These supplements provide a greater caloric density than what is currently available in the commercial market, and also offer nearly all of the Recommended Dietary Allowance for calcium in one eight-ounce serving.

Later, a decision was made by members of the DEPMEDS, Joint Working Group to downsize from a five-day menu to a three-day menu. The members felt that a three-day menu would provide sufficient variety for patients requiring a dental liquid meal, would decrease the number of national stock numbers to be assigned, and would lessen the number of ingredients a contractor would need for producing these products.

The 30 dehydrated components selected to support the three-day menu, are easily reconstituted with a blender (Fig. 1) using either six ounces or eight ounces of water (at a temperature appropriate to the product), are sippable through a straw, and taste like normal components of a meal in the liquid form. The breakfast meal is comprised of a cereal and an entree. The lunch and dinner meals are comprised of an entree, vegetable, starch, and a dessert (Fig. 2). Six flavors of dairyshake nutritional supplements are served between meals, three times a day (Fig. 3). The products can also be reconstituted with half the water required for a full liquid diet, and thus serve as a pureed/dental soft diet.

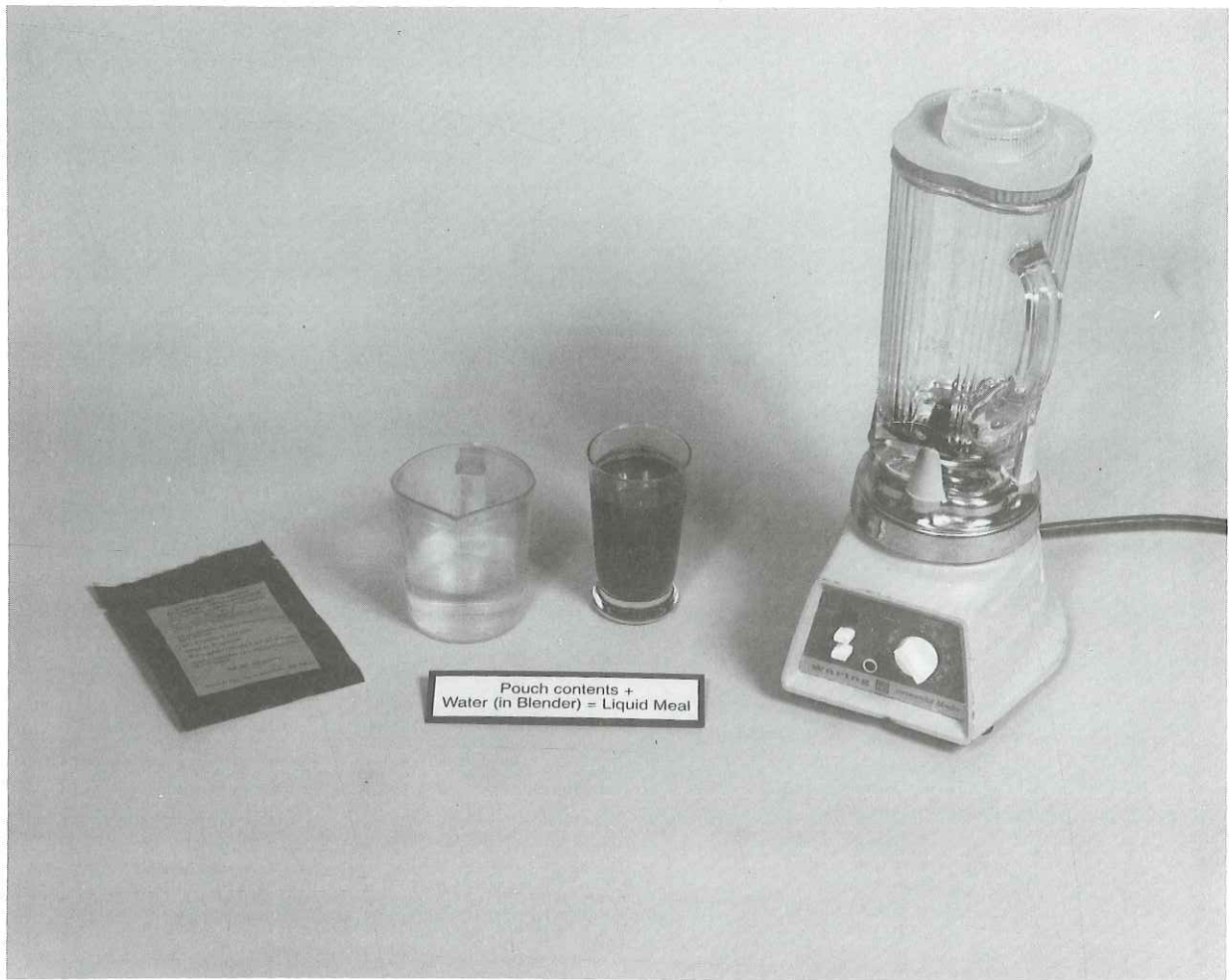


Figure 1. Dental Liquid Ration Reconstitution



Figure 2. Dental Liquid Ration Meal



Figure 3. Dental Liquid Ration Dairyshakes

Nutritional Composition

As shown in Table 1, the average nutritional content for a one-day menu is 3930 kcals, with 138 grams of protein (14 percent of the total kcals), 176 grams of fat (40 percent of the total kcals), and 506 grams of carbohydrate (51 percent of the total kcals). Colonel Fridlund, Chief, Dietitian Section, Army Medical Specialist Corps, OTSG, has reviewed and approved the DLR three-day menu (see Appendix A) based on its nutritional content. The DLR three-day menu provides sufficient kcals and protein, as well as vitamins and minerals. The detailed nutritional analysis of the DLR as approved by OTSG is provided in Appendix G.

TABLE 1. Mean Nutritional Composition

	PROTEIN (g)	FAT (g)	CHO (g)	KCALS
DAY ONE	130	165	461	3609
DAY TWO	139	175	578	3998
DAY THREE	144	189	478	4183
MEAN	138	176	506	3930

Packaging

The DLR is packaged in either individual serving pouches, or a Ten Patient Meal Module (TPMM) to facilitate serving large numbers of patients requiring the DLR.

Individual Pouches

The product is packaged in an individual serving, three-ply laminate package, consisting of food grade polyethylene as the food contact layer, aluminum foil and polyester on the exterior. The exterior of the pouch is uniformly colored for camouflage purposes. The following information is printed on each package: product name, type, ingredients listing, and instructions for reconstitution. The components are assembled by meal type (breakfast, lunch, or dinner) for days one through three, and are positioned flat and stacked in a vertical alignment. Menus are then unit packed in polyethylene meal bags and placed into three intermediate fiberboard boxes, separated by type. The intermediate boxes are then packed together in a snug fitting fiberboard shipping container (Fig. 4).

Each polyethylene meal bag is labeled using a pressure-sensitive, dull, non-reflective color (other than white) and marked using black, indelible ink with the following information: meal name, menu number, menu type, name and address of assembler.

Ten-Patient Meal Module (TPMM)

The TPMM contains enough product to feed ten patients a complete day's menu. The DLR product is packaged in Number 2 1/2 cans with plastic lids for resealing after opening. Each module contains ten dental liquids, three flavors of dairyshakes, and a fruit juice powder (to enhance the Vitamin C content). The module also contains an accessory pack with straws, napkins, salt, and pepper. Each module weighs approximately 27 pounds (Fig. 5). The shelf life of the product, once opened, has been determined to be 30 days. The TPMM is intended to be used only when there are a substantial number of patients requiring dental liquid rations. Use of the TPMM, in this type of feeding scenario, eliminates the need to open up individual serving pouches for each patient.

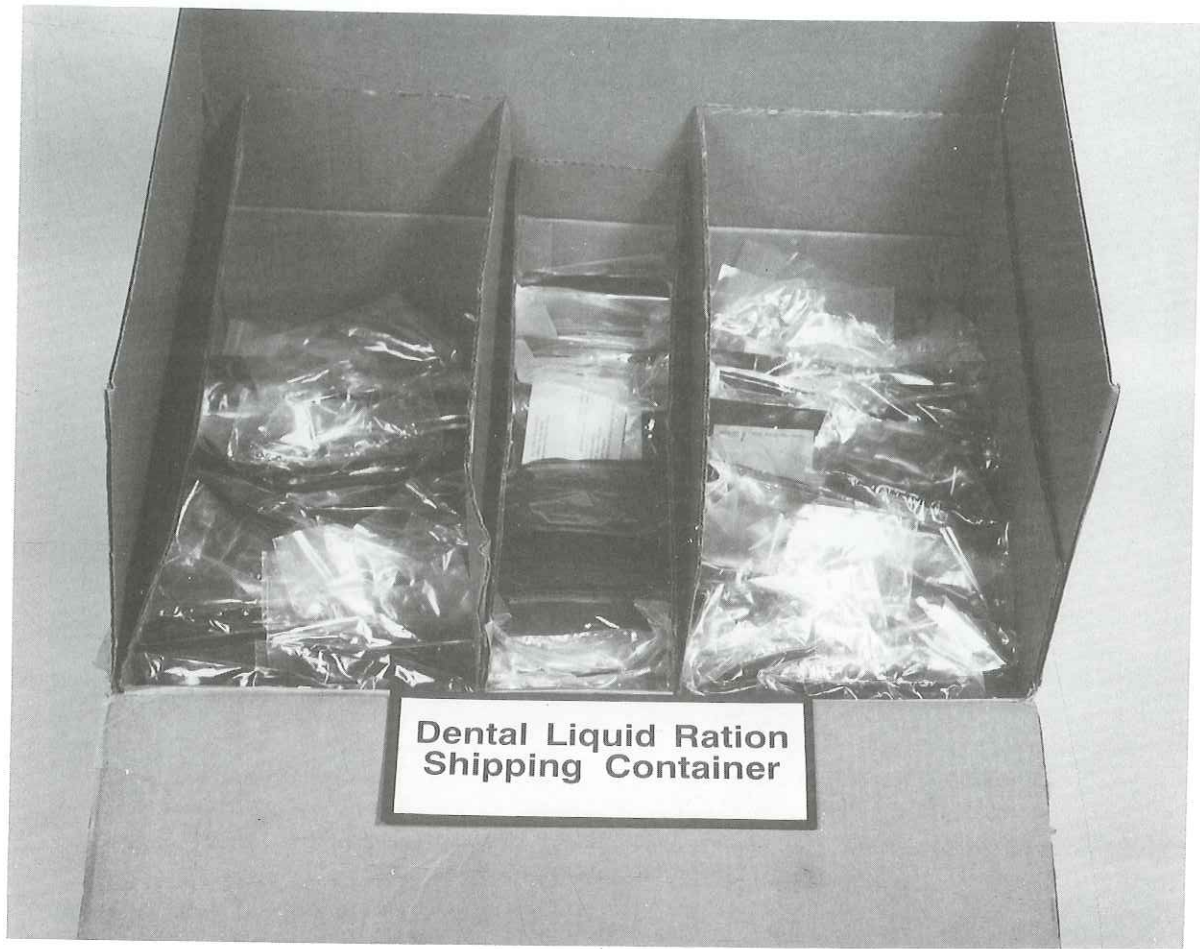


Figure 4. Dental Liquid Ration
Individual Pouch Shipping Container



Figure 5. Dental Liquid Ration
Ten-Patient Meal Module Shipping
Container

TESTING

Producibility Tests

Dairyshake

A limited production purchase description for the dairyshake was written, and a commercial producibility test to manufacture 2,000 of each of the six flavors was conducted at Thermo Pac, Inc. of Stone Mountain, GA in October 1988. Twelve thousand units were successfully completed. These dairyshakes were later used in the long term storage study and user test. A military specification was written for coordination at that time.

Meal Components

To determine if commercial production of the individually pouched meal components was feasible, technical data packages were written and a producibility test was completed by Thermo Pac, Inc., in which 1,500 of each of the components of the five-day menu were successfully produced. The contractor's final report was forwarded to Natick and all of their recommended changes were incorporated into the technical data packages. The menus produced by the contractor were used in the five-day user test conducted at tri-service and VA hospitals during 3QFY91-3QFY92.

Ten-Patient Meal Module

A packaging and assembly test of a TMM technical data package was successfully completed by Trans-Packers Services Corp. of Brooklyn, NY. The DLR product was produced in-house at Natick, and was provided to the contractor as Government Furnished Property (GFP). The contractor successfully packaged and assembled 20 of each of the five-day meal modules. The meal modules were then used for the TMM user test held at Fort Sam Houston, San Antonio, TX, during 3QFY92.

User Tests

Focus Groups

Focus groups, consisting of individuals familiar with liquid feeding, were formed to solicit information on product concepts and possible improvements, without actually collecting quantitative information. Kalick and Popper (1) conducted two focus groups, one using patients who had their jaws wired within the past year, but who were not currently wired, and a second group of patients who were presently wired for elective orthognathic surgery. Ten products were served to the two groups. Product attributes such as flavor, texture, odor, appearance, ease of sipping, serving size, and advantages or disadvantages of these products over currently available liquid foods were discussed by the groups.

Findings by Kalick and Popper (1) included: the concept of powdered foods that are prepared by adding water is appealing; the new products have nutritional and convenience benefits; a large variety of foods is important; the serving size currently recommended for meals is too large;

products should be flavorful; and, appearance is not an important issue. As a result of these findings, minor product improvements were made and the serving sizes of some products were decreased. However, the nutritional requirement established by the OTSG was maintained. It should be noted that all of these focus group subjects were females and research done by Edinberg and Engell (2) showed that female subjects consumed about half as much as the males. Therefore, the decreased serving size may not be adequate for male patients.

Army Readiness Training Evaluation Program (ARTEP)

While the products were scheduled to be tested in fixed hospital facilities, it was also desirable to investigate how the products would perform operationally in a field hospital. Currently, field hospital units are not always equipped with blenders, and electricity and refrigeration often are not readily available. The 46th Combat Support Hospital (CSH) from Ft. Devens, MA, conducted an ARTEP during April 1988, when the dental liquid products were informally evaluated by 94F's and 94B's participating in the training evaluation program. A three-day menu was evaluated. The 46th CSH set up three 20-bed wards at the Ft. Devens' Sudbury Annex, Sudbury, MA. The patient load was usually 20 to 30 patients, most of whom were on a regular diet. Blenders were unavailable, and refrigeration was lacking. Comments provided by Captain Bolan, Chief Dietitian, Nutrition Care Directorate, Cutler Army Hospital, about the dental liquid products included:

1. Hot rations blended well with a wire whip in less than one minute.
2. Cold rations did not blend well with a wire whip.
3. Partial packages were not needed for full liquid diets. The items for full liquid diets needed to be relatively bland because they were concentrated.
4. The instructions for use were easily understood, resulting in items that were easily sippable through a straw.

The test concluded that the dental liquid products were well received, and were considered an improvement over present methods of providing liquid diets. One noteworthy comment made was that due to the many diet changes during this exercise, the value of the dental liquids became apparent because they could quickly be made in the wards without having to go back to the mess tent. This test answered some basic operational-type questions, but additional operational testing on a larger scale was required.

Five Day User Test:

The Behavioral Science Division (BSD), Soldier Science Directorate at Natick conducted a ten month, five-day user test of the Dental Liquid Ration (DLR). The purpose of the evaluation, which began on 1 July 1991 and ended on 1 May 1992, was to compare the new dental liquid to diets currently used in military medical institutions. Twenty-two Tri-Service (Army, Navy, and Air Force) and Veterans Administration (VA) hospitals worldwide agreed to participate in the study. However, only 11 of the 22 hospitals that were provided with samples and questionnaires actually

participated (see Appendix C).

The test sites were identified by Tri-Service and VA representatives. Dietitians at participating hospitals were sent a booklet and demonstration video to instruct them in recruiting subjects and conducting the evaluation, administering the questionnaires, and preparing the new dehydrated products. Samples of the 5-day menu are found in Appendix D. The current diet (which varied among hospitals) consisted of pureed foods, baby foods, commercial dry and liquid products. Both diets were supplemented with drinks commonly accompanying meals, such as milk, hot chocolate, coffee, tea or juice.

Dietitians identified eligible patients and obtained physician approval and patient consent. The Dietitians instructed patients on when and how to complete rating and consumption forms. Patients were placed on either the new or existing diet depending on the date they began the study (each diet was served on alternate days). Patients were not told which diet was being served and were required to participate in the study a minimum of two days. They rated individual products on acceptance, ease of sipping, temperature and portion size and the overall meal on acceptability, meal size and satisfaction. While they were filling out the questionnaire they also noted mood and level of pain using previously validated 9-point scales labeled with descriptive categories. Data was analyzed using t-test, correlations, means and standard deviations.

The sample population consisted of 28 subjects, 25 men and 3 women, with a mean age of 28.7 years (median = 22 years). Thirty-two subjects were excluded from the study due to incomplete data. The small sample size may be due, in part, to the large institution dropout rate. Only 11 out of 22 Tri-Service and VA hospitals and service academies that were contacted participated in the present study. Attrition was due to: early discharge of patients and lack of available staff to conduct the study due to downsizing of the military forces, vacations, and incomplete data.

Averages were calculated for subjects who participated for more than two days (range = 2 to 5 days). For analysis, food items were categorized by Entree, Vegetable, Starch, Dessert, Breakfast or Fruit Juice. T-tests were performed for each factor comparing the new and existing diets. Dairyshakes were analyzed separately because no consistent between meal item in the existing diet could be used for comparison.

No significant differences for acceptance were found between the diets, except for Starch (existing = 6.3, new = 4.9, $p < .05$). Overall, the remainder of the items received ratings of 5.0 or higher with the exception of Vegetables in both diets (existing = 4.9, new = 4.4). All food items were rated on a 9-point hedonic scale where 1 = "Dislike Extremely", 5 = "Neither Like Nor Dislike" and 9 = "Like Extremely".

When acceptability ratings were correlated with the degree of hunger, amount of pain and how the patient felt, only the relationship between how the patient felt and acceptability was significant for both diets ($p > .05$). If the patient felt well, the product received a higher acceptability rating than when the patient felt poorly.

The patient felt that the portion size for both the existing and new diets was, "Just Right". Standard servings for the new diet were either 6 or 8 ounces, depending upon the food item. Portions in the existing diet varied somewhat, depending upon the hospital food service system. Consequently, no direct comparison can be made between the existing and new diets. However, Table 2 summarizes the average amount of liquids available and the average amount consumed for both the existing and new diets.

Table 2. Average Daily Consumption of Liquids at Mealtime

Food Category	Amount Available (oz)	Mean New Diet (n=28)	% Consumed	Amount Available (oz)	Mean Current Diet (n=28)	% Consumed	t	p
Entree	12	9.56(4.14)	79.7	16	8.18(5.51)	51.1	-1.25	NS
Vegetable	16	7.26(5.56)	45.3	16	6.20(5.00)	38.8	-0.85	NS
Starch	16	8.87(1.00)	55.4	16	7.61(6.01)	47.6	-1.08	NS
Dessert	12	8.79(4.47)	73.3	12	3.54(3.81)	29.5	-5.47	p<.001
Breakfast	16	13.35(5.93)	83.4	16	7.13(6.44)	44.6	-4.34	p<.001
Fruit/Juice	8	7.32(7.36)	91.5	8	7.11(7.34)	88.9	-0.10	NS

*

Numbers in parentheses are standard deviations.

When patients were asked to rate the overall variety for breakfast, lunch, dinner and total meals, there was no significant difference between the diets (Figure 6). Both diets received ratings of 6.0 or higher for texture and consistency for all food groups, which corresponded to "Slightly Gritty" and "Slightly Smooth". Both diets received an acceptable rating for ease of sipping. However, entrees were significantly easier to sip in the new diet (new = 6.8, existing = 5.8, $p > .05$) and were generally consumed in greater quantities, though no direct comparison could be made.

All six new dairyshakes received acceptability ratings of 6.8 ("Like Moderately") or higher. The portion size was "Just Right", the appearance was "Attractive", and they were perceived to be "Cold" and "Easy to Sip". The mean intake for all milkshakes was 6.8 ounces out of a total of 8 ounces, with 69 to 83 percent of the patients consuming the entire dairyshake.

Dietitians were asked questions on the amount of time required for preparation, variety of products, advantages and disadvantages of the existing and new diets. Dietitians found that the "New Entree, Starch and Vegetable" required significantly less time to prepare than the existing diet (Fig. 7). The "New Entree" was also easier to prepare than the "Existing Entree" (Fig. 8). A number of significant differences were found when dietitians were asked to rate the variety between meals for both the existing and new diet. In all cases, the new diet was rated higher than the existing diet for all but the Vegetable category.

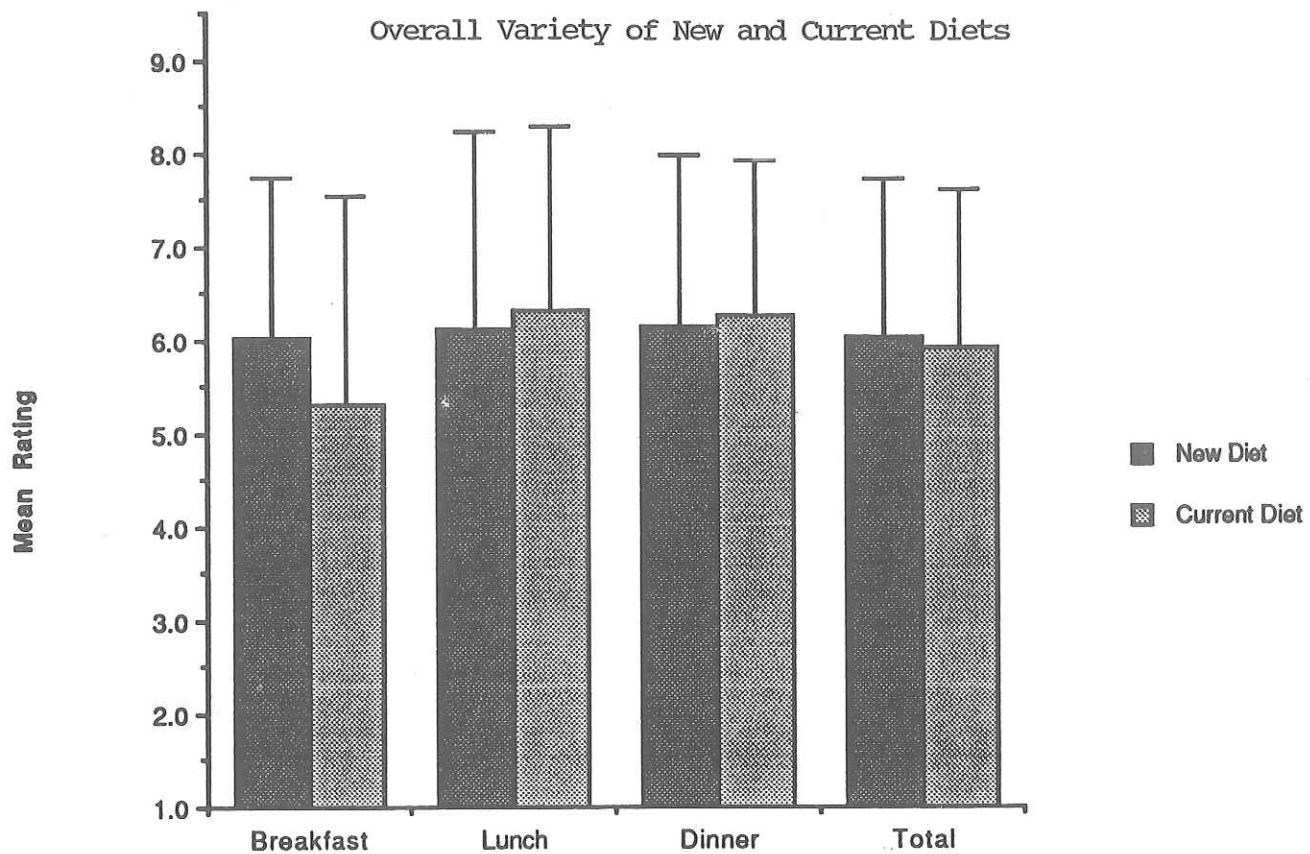


Figure 6. Using a nine-point scale where 1=poor variety, 5=neutral, and 9=excellent variety.

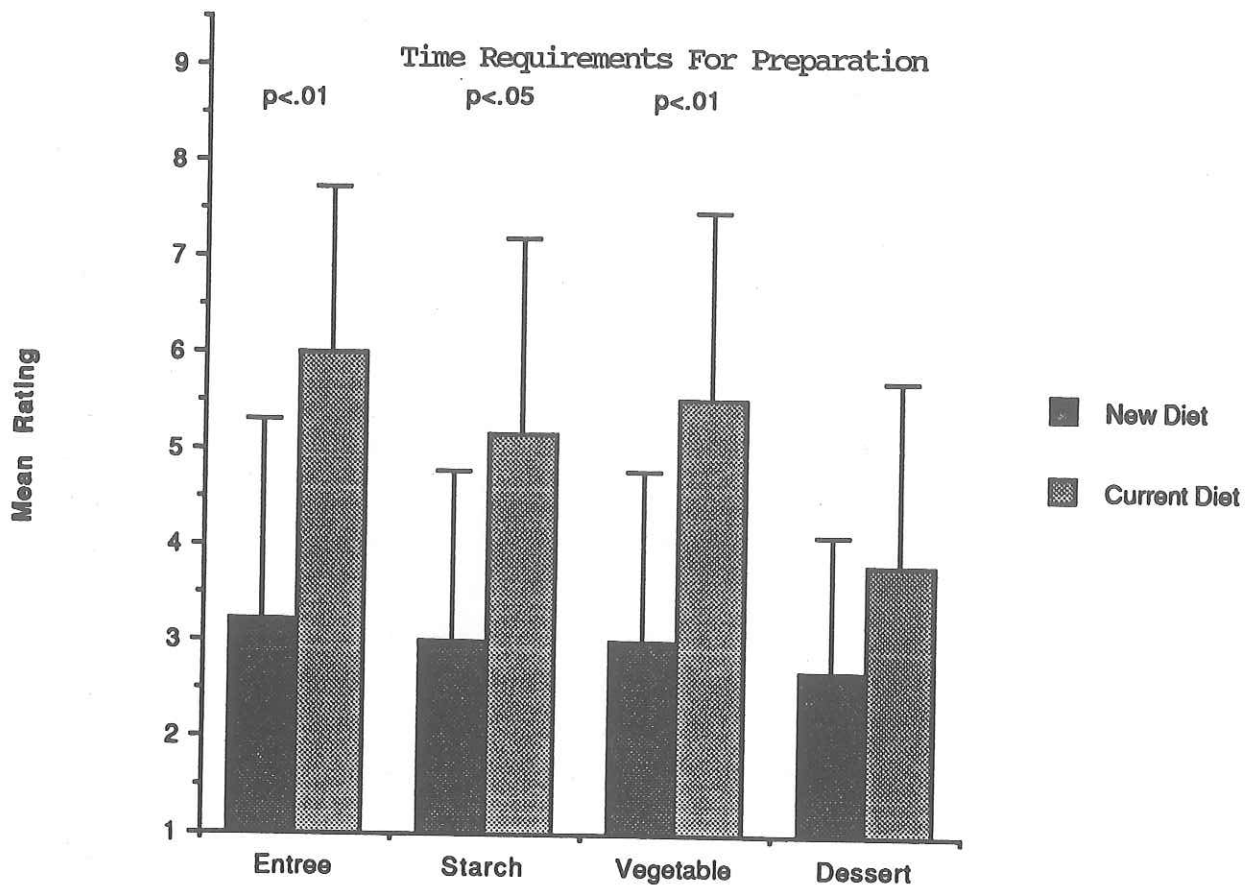


Figure 7. Answered on a nine-point scale where 1= Takes Minimal Time, 5=Neutral, and 9=Takes Too Much Time.

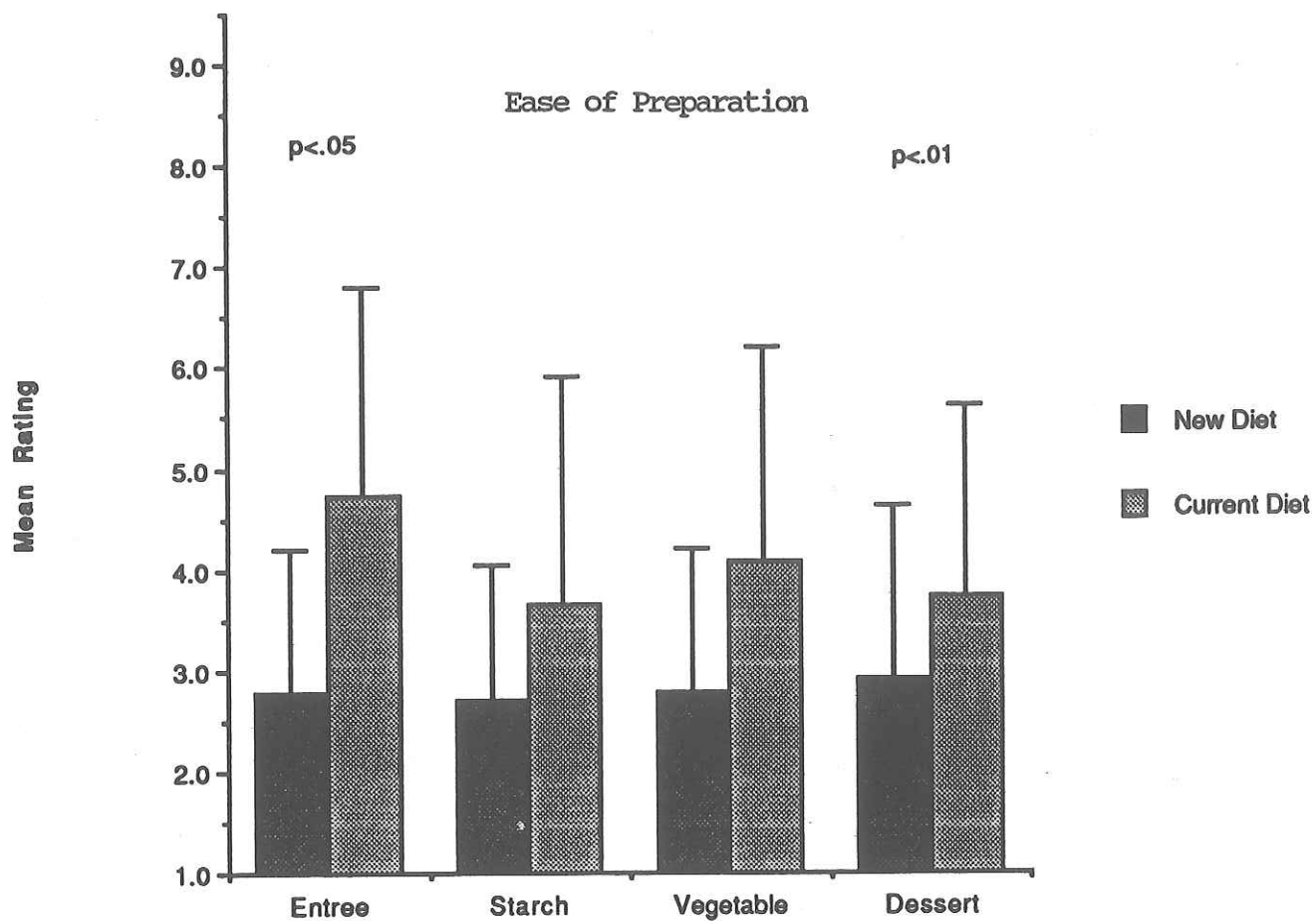


Figure 8. Answered on a nine-point scale where 1=Extremely Easy, 5=Neutral, and 9=Extremely Difficult.

Overall, dietitians found that the new dental liquid diet required significantly less time to prepare, provided a greater variety and were more acceptable to the patients than the current hospital diet. The current hospital diets were labeled as "messy and time-consuming".

Of major concern to the dietitians was the continuing difficulty in accurately determining the nutritional value of current hospital liquid diets. Dietitians found the nutritional completeness offered by the new dental liquid diet a significant benefit.

A complete report on the findings of the five-day user test has been submitted to the Journal of the American Dietetic Association for publication.

Ten-Patient Meal Module User Test

The purpose of the TPMM User Test was to determine the acceptability of the packaging and preparation procedures, and to assess the ease and efficiency of use experienced by food service personnel during the course of preparing the TPMM. The goal of the test plan was to identify any human factor deficiencies associated with the TPMM.

The subjects in this evaluation were U.S. Army reservist trainees who had a MOS91M (Medical Field Feeding Specialist). A total of 14 soldiers participated. Their length of military service ranged from six months to three and one half years, with an average of 11 months.

The evaluation of the TPMM was performed in conjunction with a four day medical field feeding exercise at Ft. Sam Houston, TX, during 3QFY92. The evaluation of the TPMM occurred on days two and three. The exercise consisted of preparing, transporting, and mock-serving the TPMM. While participants prepared the meals, they were observed by a Manpower and Personnel Integration (MANPRINT) Evaluator, as well as the Food Engineering Directorate (FED) Project Officer. After the evaluation, all of the participants completed a questionnaire, and some were randomly interviewed by the MANPRINT Evaluator.

As is noted in Appendix F, most of the tasks were found to be moderately to very easy to perform by the majority of the feeding specialists. Two tasks, "making powder measurements" and "following printed instructions", were found to be slightly more challenging by a number of soldiers. The difficulty was primarily due to their confusion with determining the appropriate powder measurements required for each.

By including the word "scoop" as a unit measure, the soldiers were confused as to how much product was actually needed. It was recommended that the instructions simply state the total amount of product to use. For instance, in this example, it would be a total of two-thirds cup of product.

The evaluation of the TPMM was successful in that it identified a human factor shortcoming that needed to be addressed, corrected, and incorporated into the final packaging specification. The instructions printed on the cans within the TPMM were clarified and revised, based on the recommendations gathered from this user test.

Aside from the initial confusion surrounding the powder measurements, the TPMM was well-liked and highly praised by all the participants in this evaluation. Once the subjects understood the measurement directions, they found that preparing meals using the TPMM was very easy, timesaving, and minimized clean-up efforts.

Storage Studies

Accelerated

Two consecutive accelerated storage studies of two weeks at 125°F were conducted on all 56 products to determine preliminary long term storage stability. Products high in tomato powder or fruit powder were found unacceptable after the initial accelerated storage, due to the hygroscopic nature of these ingredients. These items were either reformulated, dropped from the menu, or replaced by other products prior to the second accelerated storage study. At the end of the second accelerated storage study, all 56 products were found acceptable after two weeks at 125°F.

Three Year

In June 1989, a three-year storage study at 80°F was initiated on all 56 products. The storage study was completed in June 1992. Fifty six DLR components were evaluated initially and at 12, 24, and 36 months by a panel of food technologists familiar with the uniqueness of these products.

Each product was evaluated on the nine-point quality rating (one equals extremely poor, nine equals excellent) for the attributes of appearance, odor, flavor, texture and overall quality. The mean overall quality scores for the products can be found in Appendix B.

It was concluded that 43 of the 56 DLR products evaluated (77 percent) were still of acceptable overall quality after 36 months of storage at 80°F. All 36 products that comprise the final three-day DLR menu are shelf stable for three years at 80°F.

OTHER APPLICATIONS

While this ration was designed for persons with jaw injuries, many more patients could utilize this product than was originally anticipated. Because of the publicity about the dental liquid ration in newspapers, journals and magazines throughout the country, Natick received many letters and calls from patients asking when and where this ration could be purchased. These patients included not only broken jaw patients, but also patients with cancer of the throat, sinuses, and mouth; patients with swallowing disorders, such as those with Alzheimer's Disease and Lou Gehrig's Disease; and geriatric patients. Numerous inquiries also came from oral surgeons, as well as hospice nurses, relatives of patients, and nursing home coordinators asking where they could buy the products. Many of these individuals face a lifetime on liquid diets and they consider the DLR essential to their dietary needs in terms of the added variety, acceptability, and nutritional value offered by this ration.

Cooperative Research and Development Agreement

The Federal Technology Transfer Act was passed in 1986, promoting the sharing of technology between government research and development facilities and the private sector, fostering the advance of science, and enhancing the United States' global competitiveness. This act encourages the exchange of scientific technology and technical personnel among industry, academia, and government laboratories. One such means of transferring technology at Natick is through the Cooperative Research and Development Agreement (CRDA). Natick's first CRDA involved the DLR and has been in place since June 1990 between Natick and Land O'Lakes, Inc. (LOL), (originally with Procor Technologies, Inc., a subsidiary of Land O'Lakes, Inc.).

Currently, six flavors of between-meal dairyshakes, developed at Natick, have been instantized and packaged by LOL, using a resealable ziplock pouch made of trilaminate packaging material. These instant dairyshakes reconstitute quickly and efficiently, within 30 to 60 seconds, simply by shaking or mixing by hand, without the use of a blender. This unique packaging concept allows for hydration of the instant dairyshakes directly in the pouch.

Through this CRDA, the Army is gaining considerable expertise in the instantization process of the remaining dental liquid products, thus eliminating the need for a blender. In turn, LOL received dental liquid ration product formulations (public property under the Freedom of Information Act) developed at Natick. With these formulations, LOL has the capability of commercializing the dental liquid ration, thus providing a production base for both military and civilian needs.

DISCUSSION AND CONCLUSIONS

Currently used liquid products are either very sweet milkshake type drinks or bland, pureed foods that are extremely labor intensive to prepare. They usually do not meet the nutritional standards, are not highly acceptable, and are not available for outpatient use.

The 36 new Dental Liquid Ration (DLR) components support a three-day menu cycle, and consist of a wide variety of entrees, vegetables, starches, and desserts. Products include Chicken Barbecue, Lyonnaise Potatoes, Broccoli au Gratin, and Chocolate Mocha Cake. The average caloric content for a one-day menu is 3930 kcals, and the nutritional content meets the Recommended Daily Allowance for males between the ages of 19 to 51. The product will be available in either individual serving pouches, or in a Ten-Patient Meal Module (TPMM).

Storage tests, user tests, and producibility tests all indicate that the DLR components are shelf stable for three years at 80°F, easy to prepare, more sanitary, of consistent quality, nutritionally complete, are highly acceptable and producible by the commercial sector.

The individual component specifications, and packaging and assembly specifications have been coordinated with government agencies, military services, and industry. The procurement documents for the DLR were transferred to the Defense Personnel Support Center (DPSC), Philadelphia, PA in October 1992. It is anticipated that the DLR will be available for procurement by the Army, Navy, and Air Force and VA in the Fall of 1993. The DLR will be available through the Federal Supply Catalog, as well as the Federal Hospital Subsistence Guide.

This document reports research undertaken at the US Army Natick Research, Development and Engineering Center and has been assigned No. NATICK/TR-94002 in the series of reports approved for publication.

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2. Edinberg, Joanne and Engell, Dianne. Hospital Liquid Diet Evaluation, Two-Day Menu. Natick/TR-89/010, 1989, U.S. Army Natick Research, Development and Engineering Center, Natick, MA 01760

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APPENDICES

APPENDIX A

DENTAL LIQUID RATION
APPROVED THREE DAY MENU

DAY ONE

BREAKFAST

Oatmeal w/Maple & Brown Sugar
Banana-Strawberry Breakfast Drink
Orange Juice

Vanilla Dairyshake

LUNCH

Ham & Cheese Souffle
Pea Casserole
Mashed Potatoes
Apple Brown Betty

Strawberry Dairyshake

DINNER

Chili Con Carne
Cauliflower and Cheese
Escalloped Potatoes & Ham
Blueberry Upside-Down Cake

Chocolate Dairyshake

APPENDIX A

DAY TWO

BREAKFAST

Hominy Grits & Cheese
Green Pepper & Ham Omelet
Grapefruit Juice

Orange Dairyshake

LUNCH

Taco Grande
Buttered Squash
Delmonico Potatoes
Strawberry Shortcake

Eggnog Dairyshake

DINNER

Chicken Barbecue
Buttered Corn
Baked Beans
Chocolate Mocha Cake

Banana Dairyshake

DAY THREE

BREAKFAST

Peaches & Cream Farina
Ham & Cheese Fondue
Grape Juice

Vanilla Dairyshake

LUNCH

Spaghetti & Meatballs
Green Bean Casserole
Lyonnaise Potatoes
Gingerbread

Strawberry Dairyshake

DINNER

Oriental Pork w/Noodles
Creamed Corn & Potatoes
Fried Rice
Cheesecake

Chocolate Dairyshake

APPENDIX B

DENTAL LIQUID RATION THREE YEAR STORAGE STUDY (80°F)

OVERALL QUALITY

<u>MILKSHAKES</u>	<u>INITIAL</u>	<u>12 MOS</u>	<u>24 MOS</u>	<u>36 MOS</u>
BANANA	6.13	6.12	6.26	5.95
CHOCOLATE	7.35	6.71	7.05	7.16
EGGNOG	7.43	6.76	7.16	7.37
ORANGE	6.87	6.18	6.37	6.53
STRAWBERRY	7.00	6.71	7.21	7.26
VANILLA	6.65	6.24	6.47	6.16
MEAN	6.91	6.45	6.75	6.74
<u>BREAKFAST CEREALS</u>	<u>INITIAL</u>	<u>12 MOS</u>	<u>24 MOS</u>	<u>36 MOS</u>
APPLE & CINNAMON FARINA	6.00	5.82	6.00	6.27
HOMINY GRITS & CHEESE	5.91	6.00	6.59	6.53
OATMEAL W/MPL & BRN SUGAR	7.04	7.24	7.18	7.00
PEACHES & CREAM FARINA	5.57	5.24	6.12	5.40
STRAWBERRY OATMEAL	5.57	5.29	5.88	5.73
MEAN	6.02	5.92	6.35	6.19
<u>BREAKFAST ENTIREES</u>	<u>INITIAL</u>	<u>12 MOS</u>	<u>24 MOS</u>	<u>36 MOS</u>
BANANA-STRAWBERRY DRINK	6.27	6.11	6.60	6.31
FRENCH TOAST	5.68	4.26	*	*
GREEN PEPPER & HAM OMELET	5.55	5.68	5.93	5.50
HAM & CHEESE FONDUE	5.50	5.74	6.40	6.56
POTATO PANCAKES	6.64	4.26	*	*
MEAN	5.93	5.21	6.31	6.12

*French toast was not paneled at 24 of 36 mos due to deterioration (changes have been made to French Toast formulation): eliminated.

*Potato Pancake was not paneled at 24 or 36 mos due to deterioration: eliminated.

APPENDIX B

<u>STARCHES</u>	<u>INITIAL</u>	<u>12 MOS</u>	<u>24 MOS</u>	<u>36 MOS</u>
BAKED BEANS	6.14	6.47	5.88	6.35
DELMONICO POTATOES	6.50	6.29	5.83	6.32
ESCALLOPED POTATOES & HAM	6.67	6.59	6.19	5.94
FETTUCINE ALFREDO	6.48	*	*	*
FRIED RICE	6.17	6.19	5.78	6.58
LYONNAISE POTATOES	7.33	7.29	6.75	6.76
MACARONI & CHEESE	7.06	5.19	*	*
MASHED POTATOES	7.61	6.95	6.22	6.84
MEXICAN BEAN CASSEROLE	5.61	4.86	4.56	5.37
POTATOES W/BACON & CHEESE	5.86	5.47	4.19	*
MEAN	6.54	5.53	4.54	6.31

*Fettucine Alfredo was not paneled at 12, 24, or 36 mos due to deterioration: eliminated.

*Macaroni & Cheese was not paneled at 24 or 36 mos due to deterioration: eliminated.

*Potatoes w/ Bacon & Cheese was not paneled at 36 mos due to deterioration: eliminated.

<u>DESSERTS</u>	<u>INITIAL</u>	<u>12 MOS</u>	<u>24 MOS</u>	<u>36 MOS</u>
APPLE BROWN BETTY	7.41	6.63	6.86	7.13
BLUEBERRY UPSIDE-DOWN CAKE	7.24	6.38	6.86	6.06
CHEESECAKE	7.14	7.06	6.21	6.33
CHOCOLATE MOCHA CAKE	7.24	7.06	6.52	7.13
COCONUT CREAM PIE	6.06	5.19	5.38	*
COFFEE CAKE	6.68	6.83	5.86	6.13
GINGERBREAD	7.41	7.56	6.29	6.47
INDIAN PUDDING	7.00	5.44	5.95	6.44
PUMPKIN PIE	5.91	5.44	5.57	5.53
STRAWBERRY SHORTCAKE	7.09	6.17	6.07	6.00
MEAN	6.92	6.38	6.16	6.21

*Coconut Cream Pie was not paneled at 36 mos due to deterioration: eliminated.

<u>LUNCH/DINNER ENTREES</u>	<u>INITIAL</u>	<u>12 MOS</u>	<u>24 MOS</u>	<u>36 MOS</u>
AMERICAN CHOP SUEY	5.43	5.39	4.33	4.54
CHEESEBURGER	6.00	5.83	5.33	5.36
CHICKEN ALA KING	6.57	6.00	5.13	4.71
CHICKEN BARBECUE	7.04	6.67	6.90	6.40
CHICKEN POT PIE	6.26	4.56	4.73	*
CHILI CON CARNE	7.13	6.06	6.07	5.50
HAM & CHEESE SOUFFLE	6.73	6.14	5.76	6.47
ORIENTAL PORK W/NOODLES	6.50	6.48	6.24	6.00
SPAGHETTI & MEATBALLS	7.12	7.10	6.67	6.80
TACO GRANDE	6.77	6.76	6.10	6.73
MEAN	6.56	6.10	5.73	5.83

*Chicken Pot Pie was not paneled at 36 mos due to deterioration

<u>VEGETABLES</u>	<u>INITIAL</u>	<u>12 MOS</u>	<u>24 MOS</u>	<u>36 MOS</u>
BROCCOLI AU GRATIN	6.55	5.32	4.54	4.79
BUTTERED CORN	7.27	6.53	5.94	5.74
BUTTERED SQUASH	6.92	7.05	7.20	7.22
CAULIFLOWER & CHEESE	7.13	6.30	6.60	6.61
CREAMED CARROTS	6.45	4.95	*	*
CREAMED CORN & POTATOES	5.21	5.35	5.70	*
GREEN BEAN CASSEROLE	6.95	6.84	6.44	6.79
ORIENTAL VEGETABLES	5.82	4.00	*	*
PEA CASSEROLE	5.96	6.70	5.95	6.33
VEGETABLE MEDLEY	6.18	5.95	5.56	5.68
MEAN	6.44	5.90	5.99	6.17

*Creamed Carrots was not paneled at 24 or 36 mos due to deterioration

*Creamed Corn & Potatoes was not paneled at 36 mos due to deterioration

*Oriental Vegetable was not paneled at 24 or 36 mos due to deterioration

APPENDIX C

PARTICIPATING HOSPITALS IN THE DENIAL LIQUID RATION FIVE-DAY USER TEST

1. Womack Army Hospital, Fort Bragg, North Carolina
2. 97th General Hospital, 6 Frankfurt Main, Germany
3. Martin Army Hospital, Fort Benning, Georgia
4. Malcolm Grow, U.S. Air Force Medical Center,
Andrews Air Force Base, Washington, DC
5. David Grant, U.S. Air Force Medical Center,
Travis Air Force Base, California
6. Naval Hospital Great Lakes, Great Lakes, Illinois
7. National Naval Medical Center, Bethesda, Maryland
8. VA Medical Center, Togus, Maine
9. VA Medical Center, Brockton, Massachusetts
10. VA Medical Center, Beckley, West Virginia
11. VA Medical Center, West Los Angeles, California

APPENDIX D

DENTAL LIQUID RATION
FIVE DAY USER TEST MENU

DAY ONE MENU

BREAKFAST
MENU #1

Apple & Cinnamon Farina
Green Pepper & Ham Omelet
Orange Juice

SNACK

Banana Milk Shake

LUNCH
Menu #2

Chicken Pot Pie
Escalloped Potatoes & Ham
Cauliflower & Cheese
Strawberry Shortcake

SNACK

Chocolate Milk Shake

DINNER
Menu #3

Taco Grande
Mexican Bean casserole
Vegetable Medley
Cheesecake

SNACK

Eggnog Milk Shake

APPENDIX D

DAY TWO MENU

BREAKFAST
MENU #4

Hominy Grits & Cheese
French Toast
Grapefruit Juice

SNACK

Orange Milk Shake

LUNCH
MENU #5

Ham & Cheese Souffle
Lyonnaise Potatoes
Buttered Corn
Blueberry Upside-Down Cake

SNACK

Vanilla Milk Shake

DINNER
MENU #6

Chili Con Carne
Macaroni & Cheese
Buttered Corn
Coffee Cake

SNACK

Strawberry Milk Shake

DAY THREE MENU

BREAKFAST
MENU #7

Oatmeal w/Maple & Brown Sugar
Banana-Strawberry Breakfast Drink
Grape Juice

SNACK

Banana Milk Shake

LUNCH
MENU #8

American Chop Suey
Potatoes w/Bacon & Cheese
Pea Casserole
Apple Brown Betty

SNACK

Chocolate Milk Shake

DINNER
MENU #9

Chicken ala King
Mashed Potatoes
Broccoli & Cheese
Pumpkin Pie

SNACK

Eggnog Milk Shake

DAY FOUR MENU

BREAKFAST
MENU #10

Peaches & Cream Farina
Ham & Cheese Fondue
Apple Cider

SNACK

Orange Milk Shake

LUNCH
MENU #11

Cheeseburger
Baked Beans
Creamed Corn & Potatoes
Indian Pudding

SNACK

Vanilla Milk Shake

DINNER
MENU #12

Chicken Barbecue
Delmonico Potatoes
Creamed Carrots
Chocolate Mocha Cake

SNACK

Strawberry Milk Shake

DAY FIVE MENU

BREAKFAST
MENU #13

Strawberry Oatmeal
Potato Pancakes
Pineapple Juice

SNACK

Banana Milk Shake

LUNCH
MENU #14

Oriental Pork w/Noodles
Fried Rice
Oriental Style Vegetables
Coconut Cream Pie

SNACK

Chocolate Milk Shake

DINNER
MENU #15

Spaghetti & Meatballs
Fettucine Alfredo
Green Bean Casserole
Gingerbread

SNACK

Eggnog Milk Shake

APPENDIX E

FIVE DAY USER TEST RESULTS

Acceptance and Consistency Breakfast Items (Menus 1-5)

	Acceptance		Consistency	
	MEAN	SD	MEAN	SD
Pineapple Juice	7.33	2.08	7.33	2.08
Potato Pancake	7.25	0.96	7.00	1.41
French Toast	7.15	2.15	6.54	1.81
Orange Juice	7.06	1.92	7.82	1.19
Apple Cider	6.81	2.64	8.19	1.83
Apple & Cinnamon Farina	6.50	1.29	7.06	1.59
Strawberry Oatmeal	6.50	1.29	6.50	1.29
Grapefruit Juice	6.33	2.45	8.44	1.01
Grape Juice	6.29	2.33	8.00	1.08
Oatmeal w/Maple & Brown Sugar	6.18	1.85	6.71	1.45
Ham & Cheese Fondue	5.89	2.49	7.78	1.86
Banana-Strawberry Breakfast Drink	5.76	2.44	6.82	1.70
Green Pepper & Ham Omelet	5.69	2.73	6.44	2.34
Peaches & Cream Farina	5.22	2.67	7.61	1.91
Hominy Grits & Cheese	4.17	2.41	5.33	2.15

APPENDIX E

Lunch Items

	Acceptance		Consistency	
	MEAN	SD	MEAN	SD
Fried Rice	7.25	1.50	7.00	1.41
Coconut Cream Pie	7.25	1.26	7.25	1.26
Oriental Pork w/Noodles	7.00	1.83	7.00	1.41
Apple Brown Betty	6.71	2.43	6.69	1.74
Oriental Style Vegetables	6.50	2.38	6.12	2.06
Strawberry Shortcake	6.24	2.28	6.12	2.06
Baked Beans	6.13	2.28	7.25	1.88
Indian Pudding	5.94	2.35	7.06	1.73
Blueberry Upside-Down Cake	5.92	2.36	4.38	1.98
American Chop Suey	5.35	2.42	6.76	1.39
Escalloped Potatoes & Ham	5.28	2.52	6.17	1.86
Creamed Corn & Potatoes	5.24	2.28	7.00	1.73
Chicken Pot Pie	5.17	2.12	6.06	1.47
Ham & Cheese Souffle	5.15	2.76	5.77	2.01
Buttered Corn	5.15	2.30	5.92	2.25
Potatoes w/Bacon & Cheese	5.00	2.68	6.53	1.55
Cheeseburger	4.24	2.68	6.53	2.45
Pea Casserole	4.13	2.50	6.76	1.68
Lyonnaise Potatoes	4.08	2.60	5.46	2.22
Cauliflower & Cheese	3.56	2.09	6.33	1.61

Dinner Items

	Acceptance		Consistency	
	MEAN	SD	MEAN	SD
Gingerbread	7.75	0.96	7.00	1.41
Spaghetti & Meatball	7.50	1.29	7.00	1.41
Cheesecake	6.63	1.93	5.88	2.18
Coffee Cake	6.60	1.96	5.91	1.71
Chili Con Carne	6.55	2.30	6.18	1.72
Green Bean Casserole	6.50	1.73	6.75	1.71
Chocolate Mocha Cake	6.13	2.56	6.71	1.82
Fettucine Alfredo	6.00	2.16	7.25	1.26
Taco Grande	5.88	2.67	6.94	1.30
Chicken Barbecue	5.73	2.79	7.00	1.65
Pumpkin Pie	5.71	2.37	6.36	1.78
Mashed Potatoes	5.57	1.74	6.50	1.56
Macaroni & Cheese	5.50	1.27	6.45	1.51
Chicken ala King	5.50	2.35	6.50	1.40
Delmonico Potatoes	5.27	2.43	6.71	1.77
Creamed Carrots	4.86	2.44	7.08	1.71
Vegetable Medley	4.29	2.39	6.65	1.66
Broccoli Au Gratin	4.21	2.01	6.50	1.61
Buttered Squash	4.20	2.86	5.73	1.42
Mexican Bean Casserole	4.06	2.51	6.65	1.73

**Appearance and Flavor
Breakfast Items**

	Appearance		Flavor	
	MEAN	SD	MEAN	SD
Orange Juice	6.76	1.44	7.24	1.95
Apple Cider	6.62	1.96	6.73	2.34
Grape Juice	6.43	1.55	6.50	2.38
Pineapple Juice	6.33	2.31	7.67	1.53
Grapefruit Juice	6.11	2.42	6.78	2.59
Apple & Cinnamon Farina	5.94	1.59	6.17	1.72
Peaches & Cream Farina	5.83	1.92	5.67	2.54
Banana-Strawberry Breakfast Drink	5.76	1.56	5.71	2.52
Potato Pancakes	5.75	1.50	7.00	0.82
Ham & Cheese Fondue	5.72	1.96	6.06	2.62
French Toast	5.54	2.30	7.23	1.88
Oatmeal w/Maple & Brown Sugar	5.53	1.37	6.29	2.23
Strawberry Oatmeal	5.25	0.50	6.50	1.00
Hominy Grits	4.58	1.98	3.75	2.42
Green Pepper & Ham Omelet	3.94	2.16	5.38	2.78

Lunch Items

	Appearance		Flavor	
	MEAN	SD	MEAN	SD
Coconut Cream Pie	6.25	0.96	7.75	0.96
Indian Pudding	6.00	1.90	6.31	1.92
Oriental Pork w/Noodles	6.00	0.82	7.00	1.41
Escalloped potatoes w/Ham	5.88	1.76	5.00	2.74
Creamed Corn & Potatoes	5.88	1.58	5.76	2.02
Blueberry Upside-Down Cake	5.85	2.03	6.33	2.06
Fried Rice	5.75	0.96	6.75	1.71
Lyonnaise Potatoes	5.69	1.89	3.85	2.58
Baked Beans	5.56	2.19	6.19	2.17
Ham & Cheese Souffle	5.54	1.66	5.08	2.96
Chicken Pot Pie	5.47	1.87	4.94	2.41
Buttered Corn	5.46	1.45	5.67	2.19
Cauliflower & Cheese	5.35	1.62	3.33	2.38
Strawberry Shortcake	5.35	2.45	6.06	2.33
Apple Brown Betty	5.13	1.77	6.63	2.39
Potatoes w/Bacon & Cheese	5.12	1.96	5.00	2.81
Oriental Style Vegetables	5.00	1.41	6.25	2.22
American Chop Suey	4.82	1.78	5.41	2.69
Cheeseburger	4.76	2.36	4.47	2.58
Pea Casserole	4.29	1.79	4.76	2.46

Dinner Items

	Appearance		Flavor	
	MEAN	SD	MEAN	SD
Gingerbread	6.75	0.50	5.75	2.63
Spaghetti & Meatball	6.50	0.58	7.75	0.96
Fettucine Alfredo	6.50	0.58	6.75	2.22
Chili Con Carne	6.45	1.13	6.55	2.11
Coffee Cake	6.18	1.08	6.00	1.48
Chicken Barbecue	6.00	1.81	5.60	2.64
Dalmonico Potatoes	6.00	1.81	4.64	2.59
Cheesecake	5.94	0.97	3.76	2.68
Macaroni & Cheese	5.82	1.17	4.18	2.75
Mashed Potatoes	5.79	0.97	4.50	2.21
Green Bean casserole	5.75	1.50	7.50	1.29
Chocolate Mocha Cake	5.73	2.37	5.20	2.46
Creamed Carrots	5.71	1.59	5.87	2.36
Pumpkin Pie	5.57	0.85	5.50	1.91
Chicken ala King	5.36	1.22	5.29	2.67
Taco Grande	5.00	1.84	5.88	2.87
Vegetable Medley	5.00	1.84	5.88	2.87
Broccoli Au Gratin	4.93	1.54	5.93	2.62
Mexican Bean Casserole	4.82	1.38	3.94	2.41
Buttered Squash	4.55	1.81	6.73	1.90

Portion Size* and Texture**
Breakfast Items 1 to 5

	Portion Size		Texture	
	MEAN	SD	MEAN	SD
Pineapple Juice	6.00	2.65	7.33	2.08
Strawberry Oatmeal	5.75	2.22	7.25	1.71
Potato Pancakes	5.75	2.22	7.00	1.83
Grapefruit Juice	5.44	0.73	8.67	0.71
Green Pepper & Ham Omelet	5.38	1.71	7.37	2.09
Apple & Cinnamon Farina	5.17	1.47	7.39	1.61
Peaches & Cream Farina	5.17	1.29	7.72	1.90
Oatmeal w/Maple & Brown Sugar	5.12	1.32	6.94	1.85
Banana-Strawberry Breakfast Drink	5.12	1.32	6.76	2.25
Hominy Grits & Cheese	5.08	0.79	6.08	2.39
Ham & Cheese Fondue	5.06	1.16	7.83	1.79
Orange Juice	5.00	1.66	8.35	1.06
Grape Juice	4.92	2.02	8.08	1.38
French Toast	4.62	0.87	7.15	1.72
Apple Cider	4.56	1.63	8.25	1.77

*1 = much too small, 9 = much too large

**1 = extremely gritty, 9 = not at all gritty

Portion Size* and Texture**
Lunch Items 1 to 5

	Portion Size		Texture	
	MEAN	SD	MEAN	SD
Cauliflower & Cheese	6.11	1.68	5.72	1.96
Escalloped Potatoes & Ham	6.06	1.51	6.65	2.06
Pea Casserole	5.88	1.27	7.00	1.70
Buttered Corn	5.85	1.46	6.85	1.68
Chicken Pot Pie	5.78	1.48	5.76	1.86
Potatoes w/Bacon & Cheese	5.76	1.20	6.71	1.90
American Chop Suey	5.65	1.22	6.88	1.83
Ham & Cheese Souffle	5.54	1.39	6.62	1.61
Blueberry Upside-Down Cake	5.54	1.27	4.69	2.36
Apple Brown Betty	5.44	1.46	6.81	2.04
Indian Pudding	5.31	1.14	6.75	2.11
Strawberry Shortcake	5.24	1.68	6.88	1.63
Creamed Corn & Potatoes	5.24	1.09	7.12	1.76
Lyonnais Potatoes	5.23	0.83	6.38	1.94
Baked Beans	5.19	1.22	7.19	2.10
Cheeseburger	5.12	1.32	6.82	2.16
Coconut Cream Pie	5.00	0.82	7.50	1.91
Oriental Pork w/Noodles	4.75	0.50	7.00	2.31
Oriental Style Vegetables	4.75	0.50	7.00	2.31
Fried Rice	4.50	0.58	7.00	2.31

*1 = much too small, 9 = much too large

**1 = extremely gritty, 9 = not at all gritty

Portion Size* and Texture**
Dinner Items 1 to 5

	Portion Size		Texture	
	MEAN	SD	MEAN	SD
Chili Con Carne	5.82	1.40	6.36	1.69
Macaroni & Cheese	5.82	1.54	6.36	1.75
Buttered Squash	5.82	1.60	6.27	1.62
Chicken ala King	5.64	1.45	6.86	1.61
Mashed Potatoes	5.64	1.39	7.00	1.71
Broccoli au Gratin	5.64	1.28	6.79	1.42
Coffee Cake	5.55	1.51	6.09	1.92
Chocolate Mocha Cake	5.53	1.41	6.53	2.26
Pumpkin Pie	5.46	1.45	6.54	1.76
Taco Grande	5.41	1.12	7.00	1.80
Mexican Bean Casserole	5.41	1.00	7.41	1.37
Vegetable Medley	5.41	1.12	6.94	1.92
Creamed Carrots	5.36	1.15	7.29	1.82
Cheesecake	5.35	1.17	6.76	1.89
Delmonico Potatoes	5.13	1.60	6.93	2.02
Green Bean Casserole	5.00	0.00	7.50	1.91
Chicken Barbecue	4.93	1.58	6.87	2.17
Spaghetti and Meatball	4.75	0.50	7.25	2.06
Fettucine Alfredo	4.75	0.50	7.50	1.91
Gingerbread	4.75	0.50	7.75	1.89

*1 = much too small, 9 = much too large

**1 = extremely gritty, 9 = not at all gritty

Ease of Sipping* and Temperature**
Breakfast Items 1 to 5

	Ease of Sipping		Temperature	
	MEAN	SD	MEAN	SD
Grapefruit Juice	8.43	1.13	3.50	2.62
Grape Juice	8.31	1.03	2.46	1.66
Apple Cider	8.31	1.35	3.94	2.05
Orange Juice	8.29	1.26	2.94	2.14
Ham & Cheese Fondue	8.06	1.21	7.11	1.41
Peaches & Cream Farina	7.72	1.49	6.94	1.30
Pineapple Juice	7.50	2.12	4.67	4.04
French Toast	7.18	1.89	7.08	1.31
Banana-Strawberry Breakfast Drink	7.00	1.62	3.53	2.03
Green Pepper & Ham Omelet	6.81	2.59	7.13	1.45
Hominy Grits & Cheese	6.36	2.38	7.25	1.29
Apple & Cinnamon Farina	6.22	2.05	7.06	1.30
Strawberry Oatmeal	6.00	1.41	6.75	1.50
Potato Pancake	6.00	0.00	7.25	1.29
Oatmeal w/Maple & Brown Sugar	5.41	2.76	7.06	1.30

*1 = Extremely Difficult, 9 = Extremely Easy

**1 = Cold, 9 = Hot

Ease of Sipping* and Temperature**
Lunch Items 1 to 5

	Ease of Sipping		Temperature	
	MEAN	SD	MEAN	SD
American Chop Suey	6.82	2.10	7.12	1.17
Creamed Corn & Potatoes	6.69	2.12	7.06	1.44
Indian Pudding	6.69	2.18	3.88	1.71
Pea Casserole	6.65	2.09	7.00	1.22
Baked Beans	6.60	2.26	7.13	1.59
Cheeseburger	6.56	2.19	7.06	1.39
Buttered Corn	6.55	2.46	7.50	1.24
Apple Brown Betty	6.35	2.21	4.29	2.44
Strawberry Shortcake	6.33	2.57	4.28	2.49
Potatoes w/Bacon & Cheese	6.12	2.26	7.06	1.20
Ham & Cheese Souffle	6.09	2.17	7.58	1.16
Chicken Pot Pie	6.06	2.18	6.72	1.87
Cauliflower & Cheese	5.89	2.30	6.11	2.45
Escalloped Potatoes & Ham	5.61	2.62	6.83	1.98
Lyonnaise Potatoes	5.09	2.81	7.58	1.16
Blueberry Upside-Down Cake	4.73	3.10	4.33	2.53
Coconut Cream Pie	4.67	3.21	5.00	2.16
Oriental Pork w/Noodles	4.33	2.89	6.75	1.50
Fried Rice	4.33	2.89	6.75	1.50
Oriental Style Vegetables	4.00	2.65	6.75	1.50

*1 = Extremely Difficult, 9 = Extremely Easy

**1 = Cold, 9 = Hot

Ease of Sipping* and Temperature**
Dinner Items 1 to 5

	Ease of Sipping		Temperature	
	MEAN	SD	MEAN	SD
Chili Con Carne	7.09	1.51	7.50	1.57
Macaroni & Cheese	7.09	1.58	7.75	1.22
Creamed Carrots	7.00	1.84	6.43	1.70
Taco Grande	6.88	1.96	6.76	1.25
Chicken ala King	6.80	2.21	6.80	2.08
Buttered Squash	6.64	1.86	7.75	1.22
Coffee Cake	6.60	2.07	5.58	2.54
Mexican Bean Casserole	6.53	2.18	6.53	1.77
Broccoli & Cheese	6.53	2.17	6.87	2.07
Chicken Barbecue	6.53	2.33	6.53	1.68
Delmonico Potatoes	6.47	2.36	6.60	1.68
Vegetable Medley	6.41	2.43	6.71	1.45
Cheesecake	6.41	2.03	4.12	2.42
Pumpkin Pie	6.29	2.13	4.27	2.81
Mashed Potatoes	6.27	2.40	6.87	2.07
Chocolate Mocha Cake	6.07	2.12	3.20	1.86
Spaghetti & Meatballs	5.75	3.40	7.00	1.15
Fettucine Alfredo	5.75	3.40	7.25	0.96
Green Bean Casserole	5.50	3.32	7.00	1.15
Gingerbread	5.50	3.32	6.00	2.16

*1 = Extremely Difficult, 9 = Extremely Easy

**1 = Cold, 9 = Hot

APPENDIX F

TEN-PATIENT MEAL MODULE USER TEST

EASE/DIFFICULTY OF PERFORMING TASKS

	Very Difficult 1	Moderately Difficult 2	Neither Easy nor Difficult 3	Moderately Easy 4	Very Easy 5		
	N RESPONSES PER RATING					TOTAL	
TYPE OF TASK	1	2	3	4	5	N	X
Determining which items to serve	-	1	2	3	5	11	4.1
Opening the cans	-	-	-	1	13	14	4.9
Making powder measurements	-	4	5	2	3	14	3.3
Making water measurements	-	-	1	5	8	14	4.5
Following printed instructions	-	3	7	1	3	14	3.3
Pouring meal from the blender	-	-	-	2	12	14	4.9
Cleaning preparation appliances	-	-	-	2	12	14	4.9
Overall meal preparation	-	-	1	4	9	14	4.6
Overall use of the TMM	-	-	2	4	8	14	4.4

APPENDIX G DENTAL LIQUID RATION THREE DAY NUTRITION

DENTAL LIQUID RATION DAY ONE MENU:

COMPONENT:	KCAL (Kc)	PROT (Gm)	CARB (Gm)	FAT (Gm)	CHOL (Mg)	SOD (Mg)	POT (Mg)	MAG (Mg)	IRON (Mg)	ZINC (Mg)	V-A (RE)	V-E (Mg)	V-C (Mg)	THIA (Mg)	RIBO (Mg)	NIAC (Mg)	V-B6 (Mg)	FOL (Ug)	V-B12 (Ug)	CALC (Mg)	PHOS (Mg)
BAN-STRAW BFASST DRINK	215.0	6.9	32.5	6.4	-1.0	257.0	640.0	38.0	1.5	1.0	36.0	1.0	3.0	0.1	0.3	0.5	0.1	10.0	0.0	269.0	230.0
OATMEAL MPL BROWN SUG	308.0	4.7	36.9	15.8	0.0	52.0	342.0	41.0	2.3	1.2	0.0	2.5	-1.0	0.2	0.0	0.4	0.0	7.0	-1.0	52.0	209.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
ORANGE JUICE	172.0	2.2	39.1	0.8	-1.0	4.0	760.0	-1.0	0.8	0.1	148.0	-1.0	158.0	0.3	0.1	1.3	-1.0	-1.0	-1.0	37.0	59.0
HAM & CHEESE SOUFFLE	239.0	14.5	13.8	14.0	127.0	625.0	555.0	31.0	1.3	2.0	68.0	1.7	-1.0	0.1	0.4	1.1	0.1	8.0	0.4	282.0	341.0
PEA CASSEROLE	229.0	11.7	25.5	9.0	12.0	352.0	449.0	55.0	2.6	2.0	52.0	1.3	-1.0	0.5	0.2	5.0	0.1	22.0	0.0	109.0	224.0
MASHED POTATOES	156.0	3.4	20.9	6.5	8.0	462.0	466.0	24.0	0.5	0.4	32.0	0.6	27.0	0.0	0.1	1.2	0.1	4.0	-1.0	44.0	104.0
APPLE BROWN BETTY	288.0	2.2	42.0	12.4	8.0	186.0	407.0	18.0	1.2	0.5	-1.0	3.3	1.0	0.1	0.1	4.0	1.4	59.0	1.2	71.0	94.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
CHILI CON CARNE	241.0	15.1	16.4	12.8	31.0	391.0	763.0	60.0	3.7	3.0	146.0	2.8	5.0	0.1	0.2	3.4	0.1	34.0	0.4	81.0	213.0
CAULIFLOWER & CHEESE	119.0	4.9	10.5	6.4	13.0	531.0	340.0	25.0	0.8	0.8	34.0	0.4	19.0	0.1	0.1	0.7	0.1	17.0	0.1	127.0	139.0
ESCALLOPED POT & HAM	187.0	5.8	21.1	8.9	11.0	430.0	484.0	22.0	0.6	0.8	24.0	1.7	27.0	0.0	0.1	2.3	0.1	4.0	0.6	42.0	144.0
BLUBERY-UPSIDE DWN CAK	60.0	4.9	37.3	14.1	137.0	218.0	197.0	15.0	2.5	0.6	64.0	2.9	1.0	0.0	0.2	0.5	0.1	7.0	0.2	98.0	125.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
TOTAL:	3609	130.2	460.7	164.8	342	4318	8973	519.4	19.1	18.2	1971	22.7	238	1.88	4.14	22.2	1.36	207	0.09	2982	3664

APPENDIX G

DENTAL LIQUID RATION DAY TWO MENU:																					
COMPONENT:	KCAL	PROT	CARB	FAT	CHOL	SOD	POT	MAG	IRON	ZINC	V-A	V-E	V-C	THIA	RIBO	NIAC	V-B6	FOL	V-B12	CALC	PHOS
	(Kc)	(Gm)	(Gm)	(Gm)	(Mg)	(Mg)	(Mg)	(Mg)	(Mg)	(Mg)	(RE)	(Mg)	(Mg)	(Mg)	(Mg)	(Mg)	(Mg)	(Ug)	(Ug)	(Mg)	(Mg)
HOMINY GRITS W/ CHEESE	171.0	3.8	20.5	8.2	7.0	335.0	160.0	12.0	0.6	0.4	28.0	0.8	-1.0	0.1	0.1	0.9	0.0	1.0	0.0	76.0	104.0
GREEN PEPPER & HAM OME	278.0	14.7	11.0	19.5	242.0	683.0	384.0	29.0	2.4	2.0	118.0	2.1	-1.0	0.1	0.3	1.6	0.1	12.0	0.6	141.0	287.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
GRAPEFRUIT JUICE	171.0	2.1	39.7	0.4	-1.0	4.0	692.0	-1.0	0.4	0.1	8.0	-1.0	154.0	0.2	0.1	0.7	-1.0	-1.0	-1.0	38.0	68.0
TACO GRANDE	231.0	12.9	17.4	12.2	32.0	648.0	560.0	48.0	2.5	2.5	610.0	2.1	-1.0	0.1	0.2	2.3	0.1	20.0	-1.0	155.0	214.0
BUTTERED SQUASH	145.0	2.7	18.8	6.6	-1.0	235.0	327.0	21.0	0.7	0.3	136.0	1.9	10.0	0.0	0.1	0.9	0.0	7.0	-1.0	91.0	88.0
DELMONICO POTATOES	129.0	3.7	129.0	4.6	5.0	404.0	399.0	20.0	0.5	0.6	30.0	0.5	23.0	0.0	0.1	1.2	0.0	5.0	-1.0	62.0	115.0
STRAWBERRY SHORTCAKE	246.0	6.2	34.7	9.2	25.0	385.0	328.0	27.0	2.8	0.5	148.0	0.4	5.0	0.4	0.2	5.0	1.3	68.0	0.6	200.0	144.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
CHICKEN BARBEQUE	221.0	14.2	20.9	9.0	-1.0	723.0	663.0	31.0	2.1	1.0	142.0	2.8	14.0	0.1	0.2	6.4	0.1	22.0	0.3	172.0	205.0
BUTTERED CORN	268.0	6.8	39.0	9.4	9.0	100.0	645.0	60.0	0.8	1.3	100.0	1.5	-1.0	0.1	0.2	3.8	0.1	7.0	0.0	46.0	217.0
BAKED BEANS	196.0	8.5	30.7	4.4	4.0	410.0	765.0	69.0	2.5	1.0	-1.0	0.7	-1.0	0.1	0.1	1.6	0.1	17.0	0.0	120.0	175.0
CHOCOLATE MOCHA CAKE	547.0	9.5	51.9	33.5	179.0	585.0	523.0	69.0	2.7	1.0	-1.0	2.7	1.0	0.9	0.2	0.5	1.3	91.0	0.8	185.0	301.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
TOTAL:	3998	138.8	578.3	174.8	497	5321	9016	576.4	19.5	16.6	2686	19.7	202	2.55	4.29	26.7	2.59	284	-1.6	3056	3700

DENTAL LIQUID RATION DAY THREE MENU:

COMPONENT:	KCAL (Kc)	PROT (Gm)	CARB (Gm)	FAT (Gm)	CHOL (Mg)	SOD (Mg)	POT (Mg)	MAG (Mg)	IRON (Mg)	ZINC (Mg)	V-A (RE)	V-E (Mg)	V-C (Mg)	THIA (Mg)	RIBO (Mg)	NIAC (Mg)	V-B6 (Mg)	FOL (Ug)	V-B12 (Ug)	CALC (Mg)	PHOS (Mg)
PEACHES & CRM FARINA	163.0	2.6	24.7	5.9	4.0	43.0	229.0	13.0	4.8	0.4	-1.0	1.4	-1.0	0.1	0.1	1.3	0.0	3.0	-1.0	42.0	62.0
HAM & CHEESE FONDUE	323.0	17.5	6.6	25.2	54.0	1161.0	238.0	28.0	0.8	2.8	92.0	0.2	-1.0	0.1	0.2	1.9	0.1	13.0	0.3	329.0	404.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
GRAPE JUICE	208.0	0.8	51.4	-1.0	-1.0	6.0	359.0	-1.0	0.9	0.1	-1.0	-1.0	-1.0	0.6	0.1	0.6	-1.0	-1.0	-1.0	34.0	37.0
SPAGHETTI & MEATBALLS	223.0	16.5	16.8	9.9	43.0	583.0	553.0	38.0	2.5	3.0	222.0	2.0	5.0	0.2	0.2	4.9	0.1	8.0	0.6	105.0	172.0
GREEN BEAN CASSEROLE	171.0	5.8	15.8	9.8	17.0	184.0	501.0	35.0	1.1	0.7	106.0	2.0	28.0	0.1	0.2	1.5	0.1	20.0	0.1	81.0	109.0
LYONNAISE POTATOES	114.0	2.8	20.1	2.4	4.0	881.0	429.0	25.0	0.6	0.3	18.0	0.1	26.0	0.0	0.1	1.7	0.1	4.0	-1.0	37.0	72.0
GINGERBREAD	428.0	9.8	71.5	11.5	6.0	332.0	1135.0	70.0	2.6	1.0	86.0	1.4	-1.0	0.1	0.5	3.8	1.4	84.0	-1.0	428.0	286.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
ORIENTAL PORK W/ NOODLE	176.0	14.7	12.0	7.6	35.0	720.0	460.0	30.0	1.4	1.8	50.0	0.6	-1.0	0.2	0.2	4.8	0.1	14.0	0.2	115.0	169.0
CREAMED CORN & POTATO	166.0	3.7	28.2	4.3	-1.0	260.0	484.0	35.0	0.7	0.8	20.0	0.9	16.0	0.1	0.1	2.6	0.1	10.0	-1.0	17.0	122.0
FRIED RICE	236.0	4.5	27.9	11.9	33.0	733.0	250.0	12.0	0.6	0.5	30.0	2.6	-1.0	1.3	0.1	0.4	0.0	9.0	0.1	48.0	135.0
CHEESECAKE	580.0	11.7	38.3	42.2	233.0	675.0	422.0	32.0	1.0	1.0	162.0	1.0	-1.0	0.1	0.4	0.4	0.1	21.0	0.3	179.0	279.0
DAIRYSHAKE	465.0	18.0	54.9	19.3	-1.0	270.0	1190.0	63.8	0.5	2.0	456.0	1.8	0.0	0.1	0.9	0.6	0.1	12.0	0.0	590.0	594.0
TOTAL:	4183	144.0	477.7	187.5	423.9	6398	8640	508.4	18.6	18.0	2151.	16.6	68	3.32	4.67	25.7	1.31	221	-3.3	3165	3628.

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